DEPARTMENT OF THE AIR FORCE
HEADQUARTERS AIR FORCE CIVIL ENGINEER SUPPORT AGENCY

SEP 5 2002

FROM: AFCESA/CES
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SUBJECT: **Engineering Technical Letter (ETL) 02-13: Pavement Engineering Assessment Standards**

1. Purpose. This ETL supersedes ETL 99-7, 27 September 1999. This ETL provides standard procedures for:

- Identifying, validating, prioritizing, and rating airfield pavement projects. It can be used to manage Air Force pavements at the major command (MAJCOM) or HQ USAF level. The primary product is an engineering assessment, determined using the Pavement Condition Index (PCI), Structural Index, Friction Index, and Foreign Object Damage (FOD) Index (optional).
- Identifying/validating and prioritizing road and vehicular parking areas based on PCI.

Note: The use of the name or mark of any specific manufacturer, commercial product, commodity, or service in this ETL does not imply endorsement by the Air Force.

2. Application: All Air Force organizations conducting condition surveys for rating and prioritizing pavements.

2.1. Authority: Air Force Policy Directive (AFPD) 32-10, *Installations and Facilities,* and Air Force Instruction (AFI) 32-1041, *Airfield Pavement Evaluation Program.*

2.2. Effective Date: Immediately.

2.3. Ultimate Recipients: Base civil engineers (BCE) and MAJCOMs conducting facility assessments.

2.4. Coordination: Air Force MAJCOM pavement engineers, the Naval Facilities Engineering Service Center (NFESC), and the U.S. Army Corps of Engineers (USACE) Transportation Systems Center (TSC).

3. Referenced Publications.

3.1. Air Force:

- *Air Force Facility Investment Metric Directive*, 16 September 2001, available at https://www.il.hq.af.mil/ile/iler/downloads.cfm
- AFPD 32-10, *Installations and Facilities*

- AFI 32-1032, *Planning and Programming Appropriated Funded Maintenance, Repair, and Construction Projects*
- AFI 32-1041, *Airfield Pavement Evaluation Program*
- ETL 97-14, *Procedures for Airfield Pavement Condition Index Surveys*
- *Runway Friction Characteristics* (AFCESA report)
- *Airfield Pavement Evaluation* (AFCESA report)
- *Aircraft Characteristics for Airfield Pavement Design and Evaluation* (AFCESA report)

3.2. Federal Aviation Administration (FAA):

- FAA Advisory Circular (AC) No: 150/5320-12C, *Measurement, Construction, and Maintenance of Skid-Resistant Airport Pavement Surfaces*, 18 March 1997

3.3. American Society for Testing and Materials (ASTM):

- ASTM D5340-98, *Standard Test Method for Airport Pavement Condition Index Surveys*
- ASTM D6433-99, *Standard Practice for Roads and Parking Lots Pavement Condition Index Surveys*
- ASTM E274-97, *Standard Test Method for Skid Resistance of Paved Surfaces Using a Full-Scale Tire*
- ASTM E503/E503M-88 (2000), *Standard Test Methods for Measurement of Skid Resistance on Paved Surfaces Using a Passenger Vehicle Diagonal Braking Technique*
- ASTM E524-88 (2000), *Standard Specification for Standard Smooth Tire for Pavement Skid-Resistance Tests*

4. Acronyms and Terms.

AC – asphalt concrete
ACN – Aircraft Classification Number
AFCESA – Air Force Civil Engineer Support Agency
AFPD – Air Force Policy Directive
ASTM – American Society for Testing and Materials
BCE – base civil engineer
DOD – Department of Defense
ETL – Engineering Technical Letter
FAA – Federal Aviation Administration
FIM – Facility Investment Metric
FOD – foreign object damage
ft – foot
ft^2 – square foot
ICAO – International Civil Aviation Organization
IMA – Individual Mobilization Augmentees
JBI – James Brake Index
km/h – kilometers per hour
kPa – kilopascal

m – meter
M&R – maintenance and repair
m^2 – square meter
MAJCOM – major command
mph – miles per hour
NFESC – Naval Facilities Engineering Service Center
PCC – Portland cement concrete
PCI – Pavement Condition Index
PCN – Pavement Classification Number
PIARC – World Road Association
psi – pound per square inch
RCR – runway condition rating
TSC – Transportation Systems Center
USACE – U.S. Army Corps of Engineers

5. Airfield Pavements.

5.1. Engineering Assessment. This ETL can be used to determine the engineering assessment associated with the Facility Investment Metric (FIM) as outlined in *Air Force Facility Investment Metric Directive*. The FIM has a rating system consisting of three ratings: Enhancement; Degraded; Critical. This ETL uses ratings of Adequate, Degraded, and Unsatisfactory, which may be used to support FIM ratings. It should be noted that FIM ratings include other factors such as the current impact on the overall installation mission.

5.1.1. Facility Categories. The base/MAJCOM determines the appropriate FIM category for each airfield pavement facility (runways, taxiways, aprons) based on *Air Force Facility Investment Metric Directive.* Primary pavements (those absolutely necessary to perform the mission) and some other pavements should fall in the "Primary Mission" category, as determined by the base/MAJCOM.

5.1.2. Criteria for Engineering Assessment. Apply the criteria in paragraph 6 to determine or validate the facility rating as Adequate, Degraded, or Unsatisfactory. There may be numerous projects in each category.

5.1.3. Project Priorities. Apply the criteria in paragraph 7 to set priorities for projects within each category.

5.1.4. Numerical Rating System. The criteria in paragraph 8 can be used to establish a numerical rating for pavement systems and entire airfields that allows comparison throughout the MAJCOM and assesses the impact of projects.

5.2. Rating Factors. The factors used to determine assessments and ratings in this ETL are the PCI, Structural Index, Friction Index, and FOD Index (optional).

5.2.1. PCI. The PCI is a numerical rating on a scale of 0 to 100 that is determined by a visual survey based on procedures in ASTM D5340-98, *Standard Test Method for Airport Pavement Condition Index Surveys*, and ETL 97-14, *Procedures for Airfield Pavement Condition Index Surveys*. MAJCOMs are responsible for conducting condition surveys to determine the PCI of a pavement. Surveys should be accomplished every 5 years in accordance with AFI 32-1041. Currently the surveys are done in-house, by contract, Individual Mobilization Augmentees (IMA), and Guard and Reserve units. AFI 32-1032, *Planning and Programming Appropriated Funded Maintenance, Repair, and Construction Projects*, requires a PCI for projects submitted to MAJCOMs for approval. This ETL establishes a standard color code for the seven condition codes described in ASTM D 5340-98 and a simplified rating system of Good (PCI = 71), Fair (PCI = 56 to 70), and Poor (PCI = 0 to 55), as depicted in Figure 1.

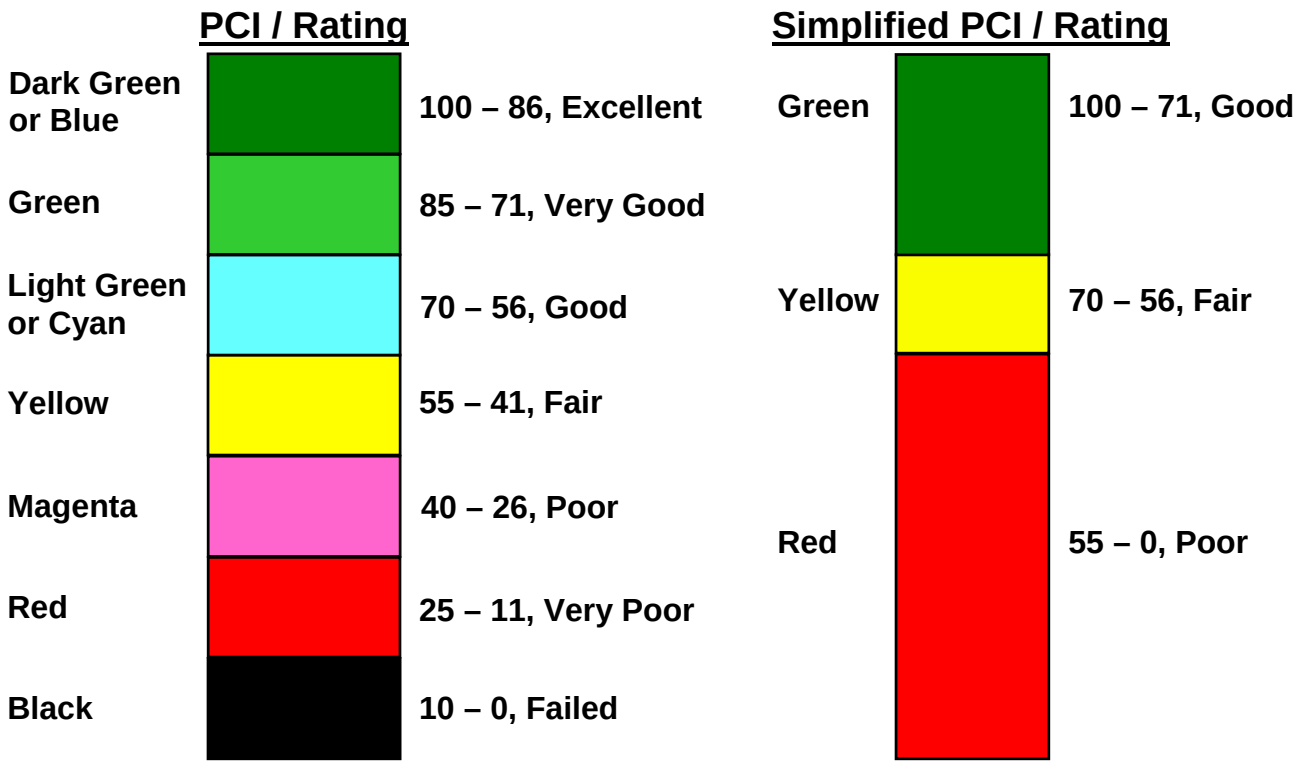

Figure 1. Pavement PCI Rating Scale

5.2.2. Friction Index. The Air Force Civil Engineer Support Agency (AFCESA) conducts tests to determine the friction characteristics of a runway, compiled in the *Runway Friction Characteristics* report; use data from the latest report. A rating system for friction characteristics for different friction equipment is shown in Table 1. The values in Table 1 will be called a Friction Index for this ETL. This ETL assumes all Air Force friction tests were conducted with the GripTester or Mu-Meter (three-wheeled trailers used for surface friction testing).

Table 1. Friction Rating

Operational Ground Vehicle Friction Levels											
Friction Rating	Ground Vehicle Readings Nominal Test Speed, 65 km/h (40 mph)[10]										
	RCR[1]	Grip-Tester[2]	JBI[3]	Mu-Meter	Surface Friction Tester[4]	Runway Friction Tester[5]	Bv-11 Skiddo-Meter[4]	Decel Meters[6]	Locked Wheel Devices[7]	IMAG[8]	ICAO Index[9]
Good	>17	>0.49	>0.58	>0.50	>0.54	>0.51	>0.59	>0.53	>0.51	>0.53	5
Fair	12-17	0.34-0.49	0.40-0.58	0.35-0.50	0.38-0.54	0.35-0.51	0.42-0.59	0.37-0.53	0.37-0.51	0.40-0.53	3-4
Poor	≤11	≤0.33	≤0.39	≤0.34	≤0.37	≤0.34	≤0.41	≤0.36	≤0.36	≤0.40	1-2

Notes:

1. RCR (runway condition rating) = decelerometer reading x 32 obtained at 40 km/h (25 mph)
2. Measurements obtained with smooth ASTM tire inflated to 140 kPa (20 psi)
3. JBI = James Brake Index obtained at 40 km/h (25 mph)
4. Measurements obtained with grooved aero tire inflated to 690 kPa (100 psi)
5. Measurements obtained with smooth ASTM 4 x 8.0 tire inflated to 210 kPa (30 psi)
6. Decelerometers include Tapley, Bowmonk, and electronic recording decelerometer at 40 km/h (25 mph)
7. ASTM E-274 skid trailer and E-503 diagonal-brake vehicle equipped with ASTM E-524 smooth test tires inflated to 170 kPa (24 psi)
8. Trailer device operated at 15% slip; grooved PIARC tire inflated to 690 kPa (100 psi)
9. ICAO = International Civil Aviation Organization
10. A wet runway produces a drop in friction with an increase in speed. If the runway has good texture, allowing the water to escape beneath the tire, then friction value will be less affected by speed. Conversely, a poor textured surface will produce a larger drop in friction with increase in speed. Friction characteristics can be further reduced by poor drainage because of inadequate slopes or depressions in the runway surface.

Friction Rating:

- Good: If each friction value is above Maintenance Level for each 152-meter (500-foot) section.
- Fair: If each friction value is above Minimum Level for each 152-meter section.
- Poor: If friction values for 3 consecutive sections of 152 meters are under Minimum Level, or if there is no value above Maintenance Level and at least one value under the Minimum Level.

5.2.3. Structural Index. The Structural Index is a ratio of Aircraft Classification Number to Pavement Classification Number (ACN/PCN). ACN represents the impact an aircraft will have on a pavement. PCN represents the capability of a pavement to support aircraft. AFCESA conducts structural evaluations for Air Force bases and publishes the *Airfield Pavement Evaluation* report that contains the PCN for each pavement feature. The Pavement Evaluation Report also contains ACN data on some aircraft. Additional ACN data is available from AFCESA's *Aircraft Characteristics for Airfield Pavement Design and Evaluation* and Federal Aviation Administration (FAA) Advisory Circular (AC) 150/5335, *Measurement, Construction, and Maintenance of Skid-Resistant Airport Pavement Surfaces*. Use the latest AFCESA report to determine the Structural Index. An ACN/PCN ratio < 1.10 is considered Good, a ratio between 1.10 and 1.40 is considered Fair; a ratio > 1.4 is Poor.

5.2.4. FOD Index. This factor is optional as FOD is not a primary concern for some MAJCOMs. At certain locations, however, FOD potential is one of the primary factors for determining the serviceability of a pavement area. A FOD Index, ranging from 0 to 100, is used to indicate the potential for FOD problems. The FOD Index is based only on pavement distresses that can produce FOD, as described in paragraph 6.1.2. A FOD Index of < 15 is considered Good: an index between 15 and 30 is Fair; and an Index > 30 is Poor. The FOD Index should be determined from the most current pavement condition survey.

6. Determining the Engineering Assessment. This section describes a procedure for determining the engineering assessment for an airfield pavement (i.e., runway, apron, or taxiway) based on four factors: PCI; Friction Index; Structural Index; FOD Index.

6.1. Step One—Determine Index. Determine the appropriate PCI, Friction Index (runway), Structural Index, and FOD Index (if required) for each pavement feature.

6.1.1. PCI. Review the most recent airfield pavement condition survey report and determine the PCI for each pavement feature. Conduct PCI surveys if the current condition is not accurately reflected in the latest airfield pavement condition survey report.

6.1.2. FOD Index. Determine the FOD Index using the PCI survey. FOD Index = corrected deduct value (see paragraph 7) using the distresses capable of producing FOD. The FOD Index can be determined by Micro PAVER or manually. Distresses capable of producing FOD are:

- Portland cement concrete (PCC) pavement - Blow-up, corner break, joint seal damage, popouts, scaling, spalling (joint and corner), patching, cracking (divided/shattered slabs, longitudinal, diagonal, transverse and durability cracking).
- Asphalt concrete (AC) pavement - Alligator cracking, longitudinal and transverse cracking, block cracking, jet blast erosion, joint reflection cracking, oil spillage, patching, raveling/weathering, slippage cracking and shoving.

6.1.3. Friction Index. Review the most recent AFCESA *Runway Friction Characteristics* report to determine the skid/hydroplaning potential of runway pavements. Divide each runway feature into 152-meter (500-foot) segments and determine the Friction Index of each segment based on tests at 64 kilometers per hour (40 miles per hour). Assign the lowest segment rating to the entire pavement feature. Rate the feature in accordance with Table 1.

6.1.4. Structural Index. Review the latest AFCESA *Airfield Pavement Evaluation* report and determine the Structural Index of each feature. Use an ACN for the most critical mission aircraft at its maximum takeoff weight.

6.2. Step Two—Determine Engineering Assessment Rating for Each Airfield Feature. Engineering assessment ratings of Adequate, Degraded, or Unsatisfactory are assigned to each airfield feature based on the criteria in Table 2. All factors must meet the criteria (i.e., if all factors do not meet the criteria, the feature rating is assigned based on the lowest factor rating).

Example: A feature is rated Adequate only if:

- PCI is ≥ 71; and
- Friction Index is >0.49; and
- Structural Index (ACN/PCN) is less than 1.1; and
- FOD Index is < 15

Table 2. Criteria for Engineering Assessment Rating

Rating/Assessment Category	PCI	Friction Index (Runways Only)	Structural Index	FOD Index
Adequate	71-100	> 0.49*	< 1.10	< 15
Degraded	56-70	0.34-0.49	1.10-1.40	15-30
Unsatisfactory	0-55	< 0.34	> 1.40	> 30

*Applies to GripTester only. For other testing equipment, use the values corresponding to Good, Fair, and Poor in Table 1.

6.3. Step Three—Determine Engineering Assessment Rating for Overall Facility. Features may be grouped together as part of one facility or requirement. Determine the rating for the facility or requirement by computing the weighted average of PCI, Friction Index, Structural Index, and FOD Index, and comparing those values to the criteria in Table 2. An example of computing a weighted average is in Paragraph 8. Table 3 shows an engineering assessment example of a runway where:

- R01A is 46 meters by 305 meters (150 feet by 1000 feet)
- R02C is 46 meters by 2438 meters (150 feet by 8000 feet)

- R03A is 46 meters by 152 meters (150 feet by 500 feet)
- R04A is 46 meters by 152 meters (150 feet by 500 feet)

Table 3. Engineering Assessment Example

	Feature	PCI	Area	Friction Index	Structural Index	FOD Index	Engineering Assessment
	R01A	78	13,935 m^2 (150,000 ft^2)	0.55	0.88	14	Adequate
	R02C	87	111,483 m^2 (1,200,000 ft^2)	0.40	0.88	10	Degraded
	R03A	76	6967 m^2 (75,000 ft^2)	0.40	1.25	16	Degraded
	R04A	65	6967 m^2 (75,000 ft^2)	0.40	1.5	25	Unsatisfactory
Weighted Values		**85 (Adequate)**		**0.42 (Degraded)**	**0.93 (Adequate)**	**11 (Adequate)**	**Degraded**

Comparing the weighted values in Table 3 to the criteria in Table 2, the engineering assessment for the runway is **Degraded,** the lowest rating of the four factors**.**

6.4. Step Four—Report Ratings. Report ratings by feature. It is also recommended the ratings be displayed on a color-coded airfield layout plan with green indicating Adequate, yellow indicating Degraded, and red indicating Unsatisfactory. An example airfield layout plan illustrating engineering assessment ratings is shown in Figure 2.

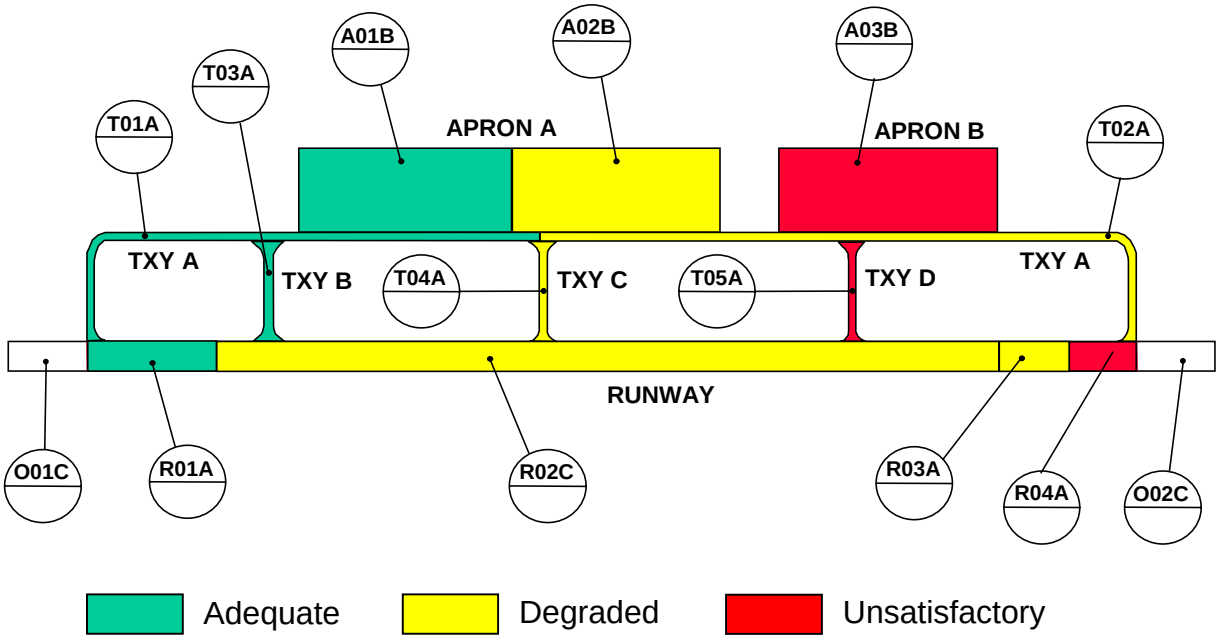

Figure 2. Sample Airfield Layout Plan

7. Prioritization of Projects. Paragraphs 7.1 through 7.3 explain a method for objectively establishing priority for projects that fall into the same category (Adequate, Degraded, Unsatisfactory).

7.1. Procedure. Determine the PCI, Friction Index, Structural Index, and FOD Index. Use Figure 3 to determine the "deduct value" for the FOD Index, Structural Index, and Friction Index. Friction deduct charts are shown for both the Mu-Meter and the Grip-Tester. Subtract each deduct value from the PCI to determine a priority order.

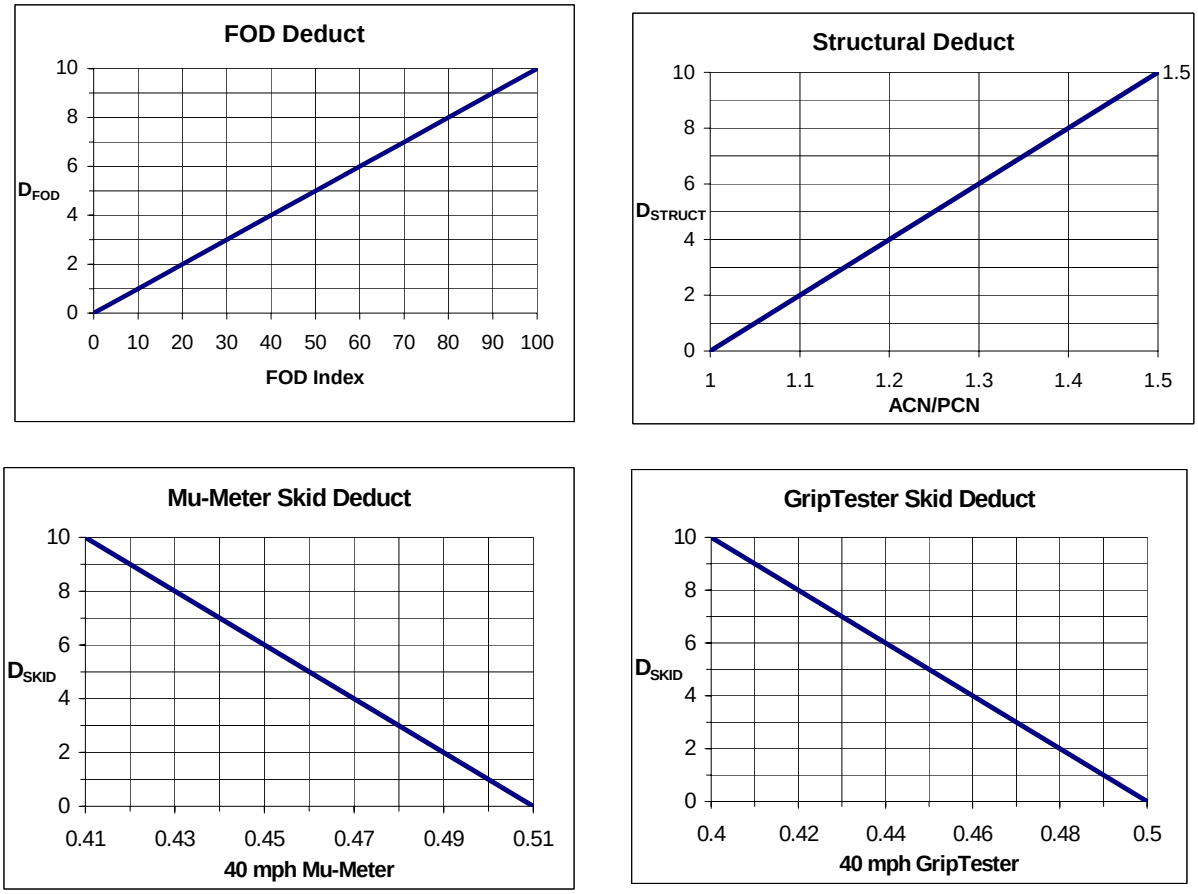

Figure 3. Deduct Values for FOD Index, Structural Index, and Friction Index

7.2. Example. Runway features fall within the Degraded category as determined by the criteria in paragraph 6.2. Pertinent information for determining the rating is shown in Table 4.

Table 4. Determination of Funding Priority*

Feature	PCI	Mu (40 mph) (GripTester)	FOD Index	Structural Index
R11A	75	0.48	10	1.4
R12A	56	0.43	30	1.3
R13A	56	0.43	20	1.3

Rating for R11A = 75 – 2 – 1 – 8 = 64
Rating for R12A = 56 – 7 – 3 – 6 = 40
Rating for R13A = 56 – 7 – 2 – 6 = 41
Priority for funding is R12A, then R13A, then R11A

7.3. Combining Features. When features are combined to form projects, use an area-weighted process for determining the rating. For example, if R12A and R13A were included in a project, the combined rating would be:

$$\text{Rating (Combined)} = \frac{\text{Rating R12A(Area R12A)} + \text{Rating R13A(Area R13A)}}{\text{Area R12A} + \text{Area R13A}}$$

8. Numerical Rating System. Some MAJCOMs may want to rate the general "health" of all facilities, including pavements, on a numerical rating scale. This section describes a procedure for calculating a pavement rating using a weighted PCI.

8.1. Procedure. Use a weighted PCI to determine the overall rating for a facility. The weighted PCI can be calculated manually or by using Micro PAVER. Assume a 3048- by 46-meter (10,000- by 150-foot) runway with:

- R21A = 304 by 46 meters (1000 by 150 feet)
- R22C = 2438 by 46 meters (8000 by 150 feet)
- R23A = 152 by 46 meters (500 by 150 feet)
- R24A = 152 by 46 meters (500 by 150 feet)

and

- PCI values of 78, 70, 54, and 52, respectively.

* Editor's Note: The following changes were made on November 25, 2002:
- R12A and R13A PCI of 55 changed to 56
- Rating for R12A = 55 - 7 - 3 - 6 = 39 changed to Rating for R12A = 56 - 7 - 3 - 6 = 40
- Rating for R13A = 55 - 7 - 2 - 6 = 40 changed to Rating for R13A = 56 - 7 - 2 - 6 = 41

The manual computation is as follows:

Weighted PCI =

$$\frac{\text{R21A PCI(R21A Area) + R22C PCI(R22C Area) + R23A PCI(R23A Area) + R24A PCI(R24A Area)}}{\text{R21A Area + R22C Area +R23A Area + R24A Area}}$$

Weighted PCI (metric) =

$$\frac{78(304.8\text{m x } 46\text{m}) + 70(2438\text{m x } 46\text{m}) + 54(152\text{m x } 46\text{m}) + 52(152\text{m x } 46\text{m})}{(304.8\text{m x } 46\text{m}) + (2438\text{m x } 46\text{m}) + (152\text{m x } 46\text{m}) + (152\text{m x } 46\text{m})}$$

Weighted PCI (inch-pound)* =

$$\frac{78(1000' \text{ x } 150') + 70(8000' \text{ x } 150') + 54(500' \text{ x } 150') + 52(500 \text{ x } 150')}{(1000' \text{ x } 150') + (8000' \text{ x } 150') + (500' \text{ x } 150') + (500' \text{ x } 150')}$$

"Health" of runway = 69

8.2. Assessing Value Added. The procedure above can be used to determine value added to a facility by a project. For example, assume a maintenance and repair (M&R) project raised the PCI of R23A and R24A to 80. The new rating for the runway is 71.8. The project increased the “health “ of the runway by 2.8 points.

8.3. Rating Scales. A MAJCOM may want to use a different scale for rating facility health. For example, it may be desirable to use a range of 85 to 100 for Adequate. This can be accomplished by applying a proportioning operation to the weighted PCI (see Table 5).

* Editor’s Note: On November 25, 2002, the equation 78(10,000' x 150') was changed to 78(1000' x 150').

Table 5. Proportioning Operation Applied to the Weighted PCI

Rating	Weighted PCI	Proportioning Operation	Numerical Rating
Adequate	100 → 71	([PCI-71]x[15/30])+85	100 → 85
Degraded	70 → 56	(PCI-56)+70	84 → 70
Unsatisfactory	55 → 0	(PCI-70/55)	69 → 0

9. Roads and Parking Lots. The only factor used to determine the engineering assessment for roads and vehicular parking lots is the PCI as determined by ASTM D6433-99, *Standard Practice for Roads and Parking Lots Pavement Condition Index Surveys*. Criteria for determining the engineering assessment are shown in Table 6 and depicted in Figure 4; use these criteria to determine the engineering assessment for each feature.

Table 6. Engineering Assessment Criteria for Roads and Parking Lots

Engineering Assessment	PCI
Adequate	71-100
Degraded	56-70
Unsatisfactory	0-55

Figure 4. Engineering Assessment Ratings

9.1. Combining Features, Reporting, Numerical Rating System. Use procedures outlined in paragraphs 6.3, 6.4, 7, and 8.

9.2. Project Prioritization. The PCI is used to establish the priority for projects that fall into the same category (Adequate, Degraded, Unsatisfactory). Projects for primary roads should be rated higher than parking lots and secondary roads.

10. Point of Contact. Recommendations for improvements to this ETL are encouraged and should be furnished to Mr. Jim Greene, HQ AFCESA/CESC, DSN 523-6334; commercial (850) 283-6334; FAX (850) 283-6219; Internet james.greene@tyndall.af.mil.

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